SERVICE INSTRUCTIONS

section DH

REMOTE DIGIT-INSERTION UNIT – RDI-3

P/N 1164-4015

(Used only in the Type 1164 Synthesizer)

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GENERAL RADIO COMPANY

West Concord, Massachusetts

SECTION DH-1

INTRODUCTION

DH-1.1 GENERAL.

The information contained in this section supplements the overall operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis."

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and appearing on the photographs are the same as those used on the complete schematic diagram and in the parts list.

The service instructions rely on the use of a properly functioning synthesizer as a basic test frame for an individual module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the wide-spread General Radio Company service organization to repair defective module, particularly on an instrument still within the two-year warranty.

DH-1.2 PURPOSE.

The RDI-3 Digit-Insertion Unit is an alternate to the DI-3 Digit-Insertion Unit, used in the General Radio 1164 70-MHz frequency synthesizer. It differs from the DI-3 in that remote frequency selection is provided for in the RDI-3. Otherwise, the two modules are directly interchangeable and serve identical functions in the instrument, which is to furnish 10-MHz user-selected steps in the instrument output.

The DI-3 and RDI-3 differ completely in function and electrical design from the remaining digit insertion units, and, although similar in mechanical configuration to the others, are not interchangeable with them.

Mounting arrangements in the chassis are identical with those of the other DI units, consisting of two front-panel screws, a plastic dial-lamp holder and dial, and a hold-down clamp at the rear of the module on the sandwich deck of the chassis.

DH-1.3 DESCRIPTION.

DH-1.3.1 GENERAL.

The RDI-3 Digit-Insertion Unit, with its cover installed, is shown in Figure DH-1. The only exter-

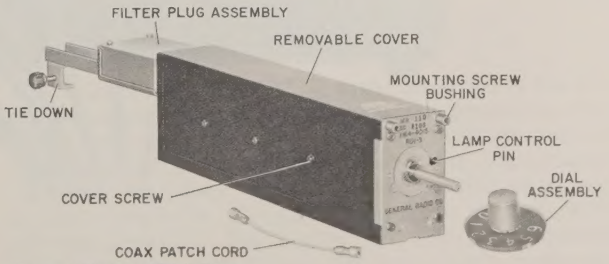


Figure DH-1. RDI-3 Digit Insertion Unit module.

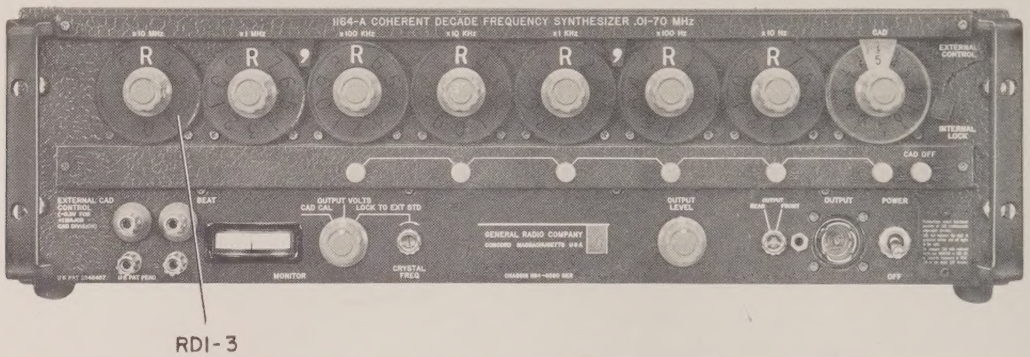


Figure DH-2. Panel view of the Type 1164-AR7C Coherent Decade Frequency Synthesizer with all digits set for programmable operation.

nal operator control of the unit, the digit-selector switch, is operated by the 1/4-inch shaft and the dial knob visible in front. The seven numbered positions of the dial permit manual frequency selection. The eighth position marked "R," transfers control of the frequency setting to the leads in the control cables at the rear of the unit. Figure DH-2 shows a synthesizer with digit-selection controls set for remotely programmable operation.

Connections for remote frequency selection are made through the filter plug shown at the rear of the RDI unit in Figure DH-1. Figure DH-3 shows the filter plugs connected to the rear of the programmable digit stations of a synthesizer. The filter plug engages a connector protruding through the rear wall of the RDI unit and the attaching screw threads into the support bar across the back of the synthesizer.

A small plastic lamp holder, which is part of the RDI-3 as supplied, fits in the synthesizer panel behind the control knob. This holder permits installation of the dial lamp in the instrument front panel, behind the dial, after the RDI-3 has been mounted in the Main Frame (see Figure 5-2 in the systems portion of this manual).

The entire RDI-3 assembly is held in the Main Frame by two 4-40 screws that engage the threaded bushings in the top corners of its small front panel and by a hold-down clamp that secures the reinforced bottom of the cover unit at the rear, through a small cutout.

Three electrical connections are automatically made to the Main Frame when the module is installed. Two are via pin plugs projecting from the sandwich deck. The dial lamp is energized in the main frame and is controlled by the RDI through a small pin projecting from its front panel. The pin contacts a spring on the lamp control panel and is part of a phase-lock sensing circuit that extinguishes the dial lamp if phase-lock fails.

The rf output of the module emerges from the bottom and is fed, via a miniature coaxial cable to the OMM-3 module.

No. 4-40 screws on either side and the bottom of the unit fasten the cover to the Digit-Insertion Unit frame structure.

After their removal, the unit can be withdrawn from the cover, if the case is held in one hand and the unit is pulled by its switch shaft with the other.

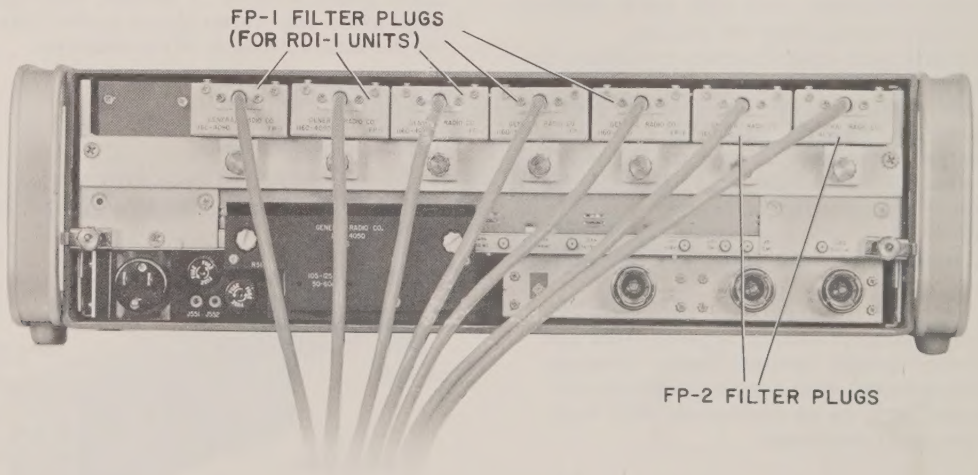


Figure DH-3. Rear view of the synthesizer of Figure DH-2, showing plug-in filters and remote cabling.

The circuitry of the RDI is contained on five etched-circuit boards. They are the long horizontal top and bottom boards and the smaller vertical front and rear circuit boards. These boards mount all components and furnish most of the electrical connections between them. In the bottom board are 2 banana jacks, 1 special ground contact, and the coaxial connector, which make the electrical connections to the Main Frame mentioned earlier.

Signal flow and circuit layout are so arranged that a minimum of wiring between boards is required and each individual board assembly can be removed from the structure, after connecting-wire leads have been unsoldered and appropriate screws removed. There is, however, enough space in almost all instances to permit removal of components without board removal.

The side rails of the top and bottom boards are equipped with special ground springs to ensure intimate contact with the cover. The 6 threaded inserts, at the sides, which accept the 4-40 screws that hold the cover, establish fixed contact areas between shield partition and cover. A finger-stock rf seal is used where the cover and front panel join, and two screws at the coaxial connector insure a proper ground at that point.

DH-1.3.2 ELECTRICAL CHARACTERISTICS.

Circuits are divided functionally at the circuit-board level, making component locations largely self-explanatory.

The RDI-3 unit supplies signal outputs, frequency coherent with the master quartz-oscillator in the AFS unit, necessary to produce the 10-MHz digit steps in the synthesizer. The function of this module in the operation of the synthesizer is described more fully in Section 4 of the front portion of this manual.

To form the 7 frequency steps (150 to 120 MHz steps) coherently from the master crystal oscillator, the RDI-3 accepts as an input, a 5-MHz sinewave from the sandwich deck. The 5-MHz signal is generated in the AFS unit, from the 5-MHz crystal oscillator (refer to Section CA of this manual). This 5-MHz input to the RDI-3 is used as the reference to phase-lock an oscillator, which has been rough-tuned by the dial switch, to any one of the desired 150 to 120-MHz output frequencies of the RDI-3. This principle is discussed more fully in Section DH-2.

The other external connections for the RDI-3 consist of the +18-volt No. 1 input from the power supply and the external lamp-control pin. The lamp-control circuit is so arranged that, if the digit oscillator fails to lock, the lamp-control pin is de-energized and extinguishes the lamp in the lamp-control assembly on the front panel, to give warning of failure.

DH-1.4 INSTALLATION.

DH-1.4.1 GENERAL.

If the RDI-3 unit is to be added to an 1164 to convert the 10-MHz step-digit station from manual control to programmable operation, observe the procedures that follow to install the unit.

DH-1.4.2 DIGIT CONVERSION.

To convert a manual-step-digit station from the DI-3 to RDI-3, proceed as follows:

a. Remove the four screws on the front panel of the synthesizer (accessible through cutouts in the handles), release the two cabinet clamps at the rear of the chassis, and withdraw the instrument from its cabinet.

b. Remove the two Phillips-head screws at the ends of the dial strip, along the top of the front panel and dismount the strip.

c. Invert the 1164 and disconnect the small coaxial cable at its OMM-3 module end.

d. Turn the instrument upright again. Set the DI-3 unit dial knob to "5," release the two knob set screws with a 3/32-inch Allen wrench and remove the knob.

e. Release the screw-actuated clamp (mounted on the chassis at the rear of the module). Turn the clamp CCW to swing it out of the recess in the DI-3 cover.

f. Withdraw the dial-light assembly from its mounting in the keyhole panel cutout. Remove the two screws at the top of the dial-light assembly.

g. Work the unit off the banana-plug attachment to the chassis, lift it clear of the plugs and draw it up and to the rear, so that the dial shaft clears the panel.

h. Remount the dial knob on the DI-3 module, remove the coaxial cable and store the unit carefully.

i. Make sure that the filter plug is disconnected from the RDI-3 module, that the dial knob is removed, and that the digit-selector shaft is set fully CCW.

j. Install the coaxial cable at J202 on the RDI-3.

k. Insert the selector shaft through the keyhole opening on the front panel of the synthesizer, work the coaxial cable through the hole in the chassis, place the unit over the banana plugs protruding from the chassis in the digit station, and press down gently to engage the plugs. Reinstall the front-panel screws.

l. Swing the chassis clamp bar into the recess in the rear of the module and tighten the screw there.

m. Remount the dial-light, the RDI-3 dial, and the cabinet. The procedure is the reverse of steps a through f. The dial should show "R" when the shaft is full CCW.

n. Reconnect the coaxial cable to the OMM-3.

DH-1.4.3 FILTER-PLUG WIRING.

The Filter Plug, FP-2, must be wired to the external programmer. For synthesizers purchased initially with programmable digits, a 50-foot roll of special 12-wire cable is furnished. For conversions or expansions this cable is recommended as an accessory available; the catalog number is 1160-9650 (50-foot lengths). See Figure DH-4 for a completed FP-2 assembly and Figure DH-5 for cable preparation details.

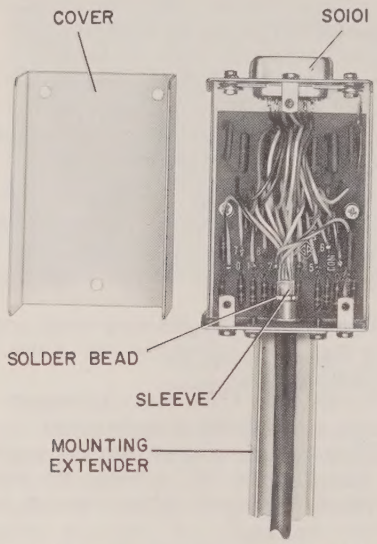


Figure DH-4. Interior view of Filter Plug FP-2 showing remote wiring connection.

To wire a Filter Plug proceed as follows:

a. Remove the three Phillips-head screws on the top of the plug assembly, to release the cover, and pull it off the unit.

b. Release the two Phillips-head screws and remove the cable-clamp-and-ferrule assembly at the rear of the plug.

c. Remove the brass shipping clip from the clamp assembly. Carefully set aside the 3/16-inch ferrule and the 3/8-inch Teflon sleeve.

d. Insert the cable through the flanged end of the opening in the clamp, so that at least 4 inches protrudes.

e. Strip 2 1/2 inches of the grey vinyl jacket from the end of the cable, taking care not to sever the braid underneath it (see Figure DH-5).

f. Remove 2 inches of the braid, measured from the end of the cable. Take care not to unravel the Mylar sheath.

g. Expand the Teflon heat-shield sleeve just enough to allow it to pass over the Mylar sheath. Use the end of a pair of needle-nose pliers.

h. Install the Teflon heat-shield sleeve over the end of the Mylar sheath and cable, approximately 1/2 inch.

i. Pull the cable back through the clamp assembly, until the end of the jacket is 1/8-inch inside the clamp.

j. Fold the braid back over the outside surface of the clamp and trim the flared ends so that they are just short of touching the shoulder of the clamp.

k. Slip the ferrule over the end of the cable and press it over the braid, back far enough for 1/8-inch of braid to be exposed at the inside end.

l. Press the Teflon sleeve back under the clamp assembly so that no more than 1/4-inch of the sleeve is still visible.

NOTE

The ferrule should not touch the shoulder of the clamp assembly.

m. Run a solder bead completely around the inside end of the assembly to bond the ferrule to the braid and to the clamp.

n. Unravel the Mylar sheath back to the Teflon heat-shield sleeve and cut off.

o. Strip the ends of the individual leads (1/4-inch) and tin the exposed wires. Cut 1/8-inch off the ends of the tinned leads. Reinstall the completed clamp assembly in the plug.

p. Press individual leads into selected lugs and solder each one at the time of insertion. (Refer to paragraph DH-1.4.4 for sequence and lug-selection details.)

q. Dress the leads as shown in Figure DH-4. The planned slack in the leads provides service loops that permit easy alteration of the wiring at a later time if desired.

DH-1.4.4 WIRING CODE SELECTION.

It is recommended that the leads of the special 12-conductor cable be soldered to the lug on the etched-circuit board of the FP-2 Filter Plug unit in the order shown in Table DH-1. This is the same sequence as for the RDI-2 (See Section DF, paragraph 1.4.6). Since the FP-2 is used both for the RDI-3 and RDI-2 in actual practice, digit "0" makes no connection in the RDI-3, this digit being the one selected when no programming information is provided. Also, digits 7 thru 9 are not provided in the RDI-3, hence, programming those digits also gives digit "0." The additional wiring in the FP-2 is provided for the RDI-2. The wiring code should conform to Table DH-1 so the FP-2 will be compatible with the RDI-2 or RDI-3.

Prepare the leads as shown in Figure DH-5.

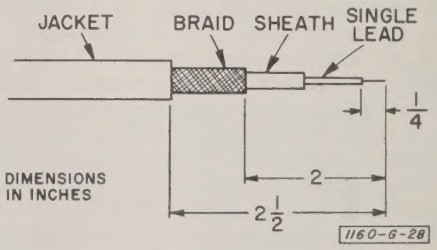


Figure DH-5. Remote-programming control cable preparation details.

DH-1.4.5 FINAL INSTALLATION.

To complete the installation of the RDI-3, proceed as follows:

a. Reinstall the cover and attach the FP-2 to the connector protruding through the rear of the RDI-3 unit.

b. Thread the clamp screw on the bottom of the plug into the tapped hole in the support bar at the rear of the synthesizer and finger tighten.

TABLE DH-1
CONTROL-CABLE CONNECTIONS
(See Figures DH-4 and DH-24)

Lug Marking	*Lead Identification*	*Digit Output for closure to COM lead**
0	White with black trace	0**
1	White with brown trace	1
2	White with red trace	2
3	White with orange trace	3
4	White with yellow trace	4
5	White with green trace	5
6	White with blue trace	6
7	White with violet trace	0**
8	White with grey trace	0**
COM	White with blue/black trace	-
+18 V	White with blue/brown trace	-
GND	White with black/brown trace	-

**Digit 0 selected when no lead is closed to COM.*
***See paragraph DH-1.4.4.*

c. Select an adequate length for the cable to reach the programmer and cut the cable. Attach it to the programmer, observing the color-code selections indicated in Table DH-1.

DH-1.5 OPERATION.

DH-1.5.1 GENERAL.

The selection of an RDI-3 digit frequency, from a remote location connected to the synthesizer by wire, is accomplished by establishing connections between these wires. As long as the dial of the RDI-3 unit is set to one of the digits 0-6, the digit frequency corresponding to this local selection is generated regardless of any normal remote-wire connection. In the "R" dial position, control of frequency is transferred to the output terminals of the FP-2 unit, from which point it may be extended as desired.

For programmed operation, the unit is controlled by a 7-line code. Digit selection can be accomplished by closure between wires by contact, by transistor switch, or other suitable means. Switching power is internally supplied. The time interval occuring between contact closure and the presence of a newly selected frequency is 0.2 ms, maximum.

DH-1.5.2 SEVEN-LINE OPERATION.

In the seven-line mode, each digit selection is made by one closure only, so 7 lines (one common lead and six digit leads) are required. The code is listed in Table DH-1, all closures being made to the COM lead.

NOTE
Closures made to 7 thru 9 yield digit 0.

SECTION DH-2

PRINCIPLES OF OPERATION

DH-2.1 GENERAL.

In this section, reference is made to the elementary block diagram, Figure DH-6, and the complete schematic diagram, Figure DH-22.

The principal circuit in the RDI-3 is a sampled-data, automatic-phase-control system that uses 5 MHz as a reference signal to lock a rough-tuned oscillator to a multiple of 5 MHz, chosen in the band of frequencies from 150 to 120 MHz.

The 5-MHz sinewave input is converted to a short-duration, high-peak-power pulse with a 5-MHz repetition rate. This pulse is used to operate a gate connected to the output of the digit oscillator which, when opened by the pulse, connects the output of the oscillator to a holding capacitor that stores the instantaneous value of the oscillator output voltage when the sampling pulse occurs. If the oscillator is tuned exactly to an integer multiple of the 5-MHz input, the value of the sample is the same each time and the voltage on the holding capacitor is dc. If there is a difference between the oscillator frequency and the corresponding multiple of the 5-MHz input reference, a stepwise sinewave signal results, which represents the drift between the oscillator and the closest multi-

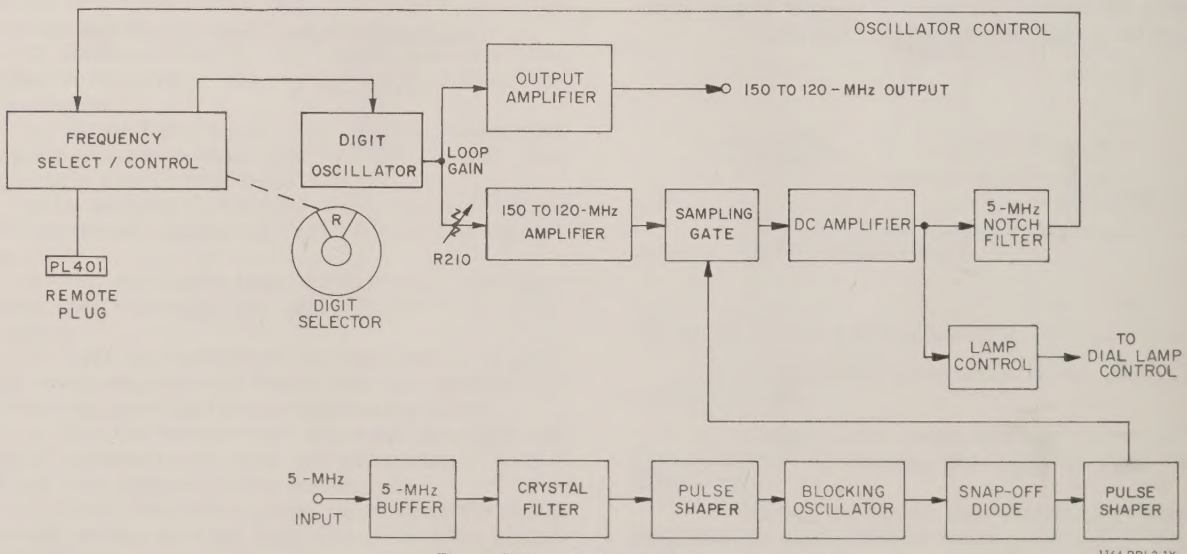


Figure DH-6. RDI-3 block diagram.

ple of the 5-MHz reference. The amplified holding-capacitor voltage is used as an error signal to phase-lock the oscillator. Figure DH-7 shows the nature of this error signal.

Since an ac component of the error signal is present only when the oscillator is not locked, it can be used to indicate malfunction. The error signal is sensed for presence of ac; and, if ac is found, the dial lamp is extinguished (refer to paragraph DH-2.7).

The operating principles of individual circuits are discussed in more detail below.

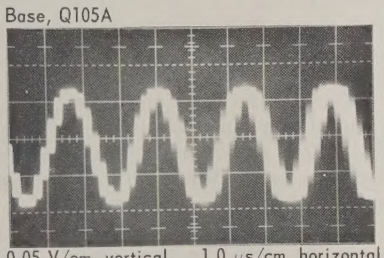


Figure DH-7. Step-wise sinewave signal at the base of Q105 indicative of the operation of the sampler circuit in response to oscillator drift (open loop).

DH-2.2 PULSE GENERATOR.

The 5-MHz input enters via J203. From this point, it is fed to a tuned isolation amplifier (Q201/T201) located at the front of the unit on the bottom board. The output link on T201 feeds a crystal filter located on the bottom board. The filter removes 100 kHz and 1-MHz sidebands, present in small amounts on the input signal, to ensure a clean RDI-3 output signal. The output of the filter feeds the pulse shaper on the top board.

The pulse shaper is comprised of the circuit involving Q101 and Q102, connected as an emitter-coupled clipper. Q102 is biased at 9 V and the 5-MHz signal from Q201 is fed to the base of Q101. This arrangement results in a 5-MHz square-wave current in each collector. The current in Q102 is fed to L101, which rings at its self-resonant frequency for one-half cycle (or until CR101 conducts, dissipating the energy in L101). Waveforms representative of the action of this circuit appear in Figures DH-12 and DH-13.

The resulting pulse is amplified in Q103 and another self-resonant choke, L102, shortens the spike further. This spike triggers the monostable blocking oscillator Q104/T101, and the blocking oscillator cycles once for each pulse received from Q103. The amplitude of the blocking oscillator is controlled by R109. Waveforms of these various parts of the circuit can be seen in Figures DH-14 and DH-15.

The load for the blocking oscillator consists of R110 and a snap-off diode, CR103, at the end of a coaxial delay line Z101. When the blocking oscillator turns on negatively, CR103 turns on also, since its anode is effectively grounded for low frequencies, through delay lines Z102 and Z104. While it is conducting, a certain amount of charge is stored in the diode junction so that, when the blocking oscillator turns off abruptly, the diode retains its high conductance (because of the mobile carriers in its junction) until the charge is swept out. Then, as the stored charge is abruptly exhausted, the diode turns off in a fraction of a nanosecond (Figure DH-14).

This sharp transition creates a negative pulse at the anode of CR103, which propagates down Z102 until it reaches the junction of Z103 and Z104. The reflection of this pulse, from the end of shorted clipping line Z104, returns to the junction of the three delay lines with reversed phase, canceling the input. The electrical length of Z104 thus determines the width of the pulse. The pulse travels down Z103 to the sampling gate.

Delay lines Z101 through Z104 consist of the four sections of preformed, semirigid, 50-ohm coaxial cable mounted on the top board.

DH-2.3 DIGIT OSCILLATOR.

The Digit Oscillator, Q202, is part of the bottom etched-circuit assembly; it is Colpitts connected, with grounded base. The oscillator is tuned in 5 MHz steps between 120 and 150 MHz, by circuits that change the bias on varactors CR201 and CR202, both for digit selection and phase lock. CR203 is in series with the varactor bias and is connected to cancel the contact potential of the varactor, so changes in varactor contact potential with temperature do not affect the oscillator frequency. Temperature coefficients of C209 and C210 compensate the remaining drifts of the oscillator.. The varactors are in parallel for dc control (ground to AT208) and in series for the rf (across L202).

The 120-150-MHz output of the oscillator is taken from L202 and distributed in parallel amplifier paths, refer to paragraph DH-2.5.

DH-2.4 FREQUENCY-SELECTION CIRCUITS.

The digit-oscillator frequency tuning of the module is accomplished electronically, controlled by electrical contact closures to ground. In the case of manual operation, the contact closures are made by S401. When remote operation is selected, S401 grounds PL401-14 and the contact closures are made from the appropriate PL401 terminal (2 through 7) to PL401-14. Contact closures to PL401-14 instead of chassis ground ensure that the module will ignore remote programming information when manual operation is selected.

The frequency-selecting element consists of a voltage divider connected between the output of the dc amplifier (paragraph DH-2.7), at +12-Vdc bias, and ground. From Figure DH-8, with R_1 fixed, as R_2 is varied, the varactor bias varies according to the expression

$$E_T = \frac{12\ R_2}{R_1 + R_2}$$

so as $R_2 \rightarrow \infty$, $E_T \rightarrow 12$ and as $R_2 \rightarrow 0$, $E_T \rightarrow 0$.

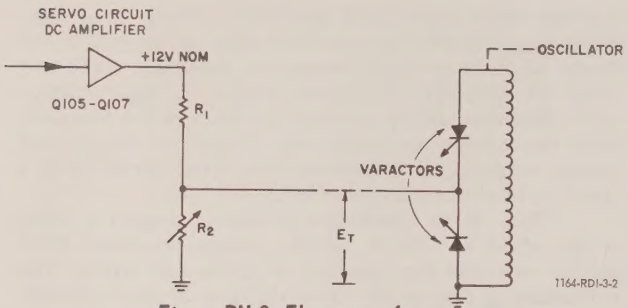


Figure DH-8. Elementary frequency-selecting circuit, RDI-3.

Thus, the selection of R2 controls the varactor bias and thereby determines the digit-oscillator frequency.

The voltage divider, in addition to providing the bias change for the rough tuning of the digit oscillator, also acts upon the phase-error information coming from the dc amplifier. This arrangement is provided so that, as the varactor bias is lowered (which increases the voltage sensitivity of the varactors), the loop gain of the phase-lock loop is held relatively constant. Without this compensation, the phase-lock loop would self-oscillate at the lower frequencies, due to the rise in sensitivity of the varactor $\Delta C/\Delta V$ at low varactor voltages.

In the module, 6 sets of resistors combine to provide 6 separate values for R_2, preselected to give the 7 desired output frequencies. They are the elements of the "control circuit" board.

NOTE

One "value" of R_2 is ∞, so no selector is required. This corresponds to the highest frequency selected.

Each of the 6 resistor sets consist of one fixed resistor and one potentiometer, mounted on the rearmost etched board beneath connector PL401. The resistors are selected by transistor switches Q401 to Q412, two at a time. A transistor pair is turned on by grounding its input base through the appropriate bias resistor (R407-R412), which causes the output transistor to saturate and connect the end of the "tuning" resistor to GROUND through its collector circuit.

The action is the same whether the grounding operation occurs at the switch or plug, since S401 and PL401 are in parallel for digit selection.

DH-2.5 AMPLIFIER CIRCUITS.

The bottom board contains three amplifiers, one at 5 MHz and two at the digit-oscillator frequency. The 5-MHz input amplifier, Q201, is a common-emitter amplifier with tuned output. It is driven by 5 MHz entering from the sandwich deck at J203. The tuned output transformer of this stage (T201) supplies 5 MHz to the top etched-board assembly.

Two high-frequency rf amplifiers are used in the module. They are driven in parallel by the digit oscillator, one providing the output signal at J202, and the other driving the sampler in the phase-lock loop.

The two are essentially identical, transformer-coupled, common-base amplifiers, the output amplifiers each having one stage. The transformers are 2:1 step-down, giving a 4:1 impedance transformation. The gain per stage is approximately 6 dB. Each amplifier has a high forward-to-reverse gain ratio, which effectively prevents disturbances at their outputs from affecting the digit oscillator.

The amplifier in the servo-loop consists of Q203/T202. R210, the adjustable element in the input attenuator of the amplifier, controls loop gain by adjustment of the rf drive to the sampler.

The output amplifier is comprised of Q204/T203. R215 adjusts the drive to this stage, setting the rf output level.

DH-2.6 SAMPLER AND DC AMPLIFIER SYSTEM.

DH-2.6.1 GENERAL.

The top board contains the balance of the circuitry in the servo loop, including the pulse generator described in paragraph DH-2.2. The remainder of the circuits in the system include the sampler dc control amplifier, described in the following paragraphs.

DH-2.6.2 SAMPLER.

The sampler is a normally closed gate circuit. This gate is "opened" on command from the 5-MHz repetition-rate pulse from the pulse generator described in paragraph DH-2.2. The gate remains open only for the duration of the pulse, 1 ns. When the gate is open, the impedance between AT102 and the top of C109 is very low; otherwise it is very high.

The gating function is performed by the high-speed sampling diodes, CR104A-CR104D. The circuit is arranged so that the diodes are normally back biased by their contact potential. A sampling pulse advancing down Z103 is converted by T102 to balanced drive for the sampler. The current in this pulse turns the diodes on.

When the diodes are turned on, the impedance between AT102 and the top of C109 is very low and C109 changes very rapidly to the value of the lock-sensing signal at AT109. When the gate is closed, the low leakage of the diode allows C109 to hold the value of that "sample" until the next pulse arrives. R111 balances the driving pulse; L103 and L104 bring bias to the output of the diode bridge and equalize the charge on C107 and C108, before arrival of the next pulse.

C109, when the gate is closed, is loaded only by a very high impedance determined by the Q105 bias current and the reverse-leakage current through the diodes; it therefore discharges very slowly. The dc component of current in these two discharging loads

is canceled by a current fed to this point of the circuit by R115, a 820 kΩ resistor. This current is determined by the setting of R116 "Sample Hold Slope," which is adjusted so that the value of the sample charge in C109 (and the voltage across C109) is retained with minimum change, until replaced by the next sample, 200 ns later.

DH-2.6.3 DC AMPLIFIERS.

The dc amplifier in the servo loop consists of Q105 and Q106, connected as a differential amplifier, and Q107. The overall voltage gain with feedback is about 7 and is designed for zero offset and minimum drift. This amplifier provides a low source impedance for the frequency-selector circuits, minimum loading on C109, and additional loop gain.

An adjustable 5-MHz notch filter (consisting of L107, C113/C114) is in series with the control line of the oscillator, so that any 5-MHz component appearing at the output of the dc amplifier does not appear at the digit-oscillator control input. Such a signal, if present, would create 5-MHz fm sidebands on the output of the module.

DH-2.7 RECAPITULATION – OSCILLATOR CONTROL.

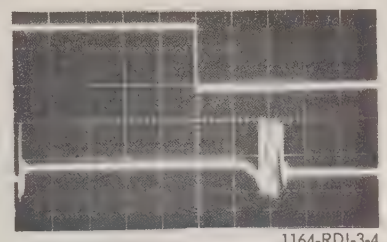
In the preceding paragraphs, the individual parts of the oscillator locking system have been described. These elements make up the oscillator locking scheme, to maintain the selected frequency outputs at strict multiples of the incoming 5-MHz signal.

In review, the rf output of the digit oscillator is sampled at a 5-MHz rate controlled by the 5-MHz input. If the frequency of the digit oscillator is exactly 30 times the input signal (5-MHz), exactly 30 cycles of the 150 MHz will occur between samples and the value of the sample will be exactly the same each time. Its value will depend on the phase and amplitude of the 150-MHz signal. Likewise, if the rf is exactly 145 MHz, 29 cycles will occur between samples and the value at the instant each sampling pulse occurs will again be the same as at the previous one. The output of the sampler, since the sample is "held" by C109, will therefore be dc, if the frequency is any exact multiple of the 5-MHz sampling rate. Thus, the sampling system can make no distinction as to which multiple is being observed, only that it is, in fact, a multiple of the sampling rate.

The output of the dc amplifier is connected via the frequency-selector circuits to the digit-oscillator varactors, CR201 and CR202, and corrects the digit-oscillator frequency as required to establish the integral relationship of this frequency to 5 MHz at a multiple as chosen by the position of switch S401, or through the remote plug PL401.

Typical switching behavior of the synthesizer output frequency, as a result the action of this programmable digit unit, is shown in Figure DH-9.

Details of the frequency-correcting action of this servo loop are as follows. Unless the oscillator frequency is exactly correct, each sample will have a different voltage than the last, due to the phase drift of the input relative to the pulses. If the frequency is too low, each succeeding sample will have a higher voltage than the last (assuming the samples are being taken on the negative slope of the sinewave). This will place a higher voltage on the varactors, which lowers their capacitance and raises the frequency of the oscillator. In a like manner, if the frequency is too high, a lower voltage will appear at the output of the sampler from one sample to the next, which will reduce the varactor voltage and lower the oscillator frequency. Thus, in equilibrium, the voltage from the sampler is determined by the phase of the oscillator with respect to the sampling pulses and adjusts itself continuously, as necessary, to maintain the oscillator frequency at an exact multiple of the sampling frequency.



1164-RDI-3-4

Upper trace – Switch Control Signal
10 V/cm Vertical
Lower – Feedback Loop Response at AT110

Figure DH-9. Switching behavior of the RDI-3 module in response to remote control through the FP-2 plug. The upper trace (at 10 V/cm vertical) is the switch control signal. The lower trace is the oscillator control feedback loop response at AT110. The horizontal scale for both is 10 μs/cm.

DH-2.8 LAMP-CONTROL CIRCUIT.

This circuit is mounted on the front etched-circuit board of the module and functions to extinguish the pilot light in front of the digit dial, if the reference signal is present but the oscillator fails to lock. This function is accomplished by sensing for the presence of ac on the oscillator control line. If ac is present, this implies that either the oscillator is not locked or the phase-lock loop is self-oscillating, either condition being a malfunction. Ac amplifier Q301 will amplify any ac present on the oscillator control line. If any ac is present, it is detected by CR301 and CR302. This changes the bias on Q302, driving Q302 out of conduction. If this occurs, the voltage on the lamp-control pin drops to zero and the lamp-control transistor on the chassis lamp-panel assembly cuts off and extinguishes the lamp. (Refer to Section BC, on the chassis, for discussion of the operation of this circuit.)

SECTION DH-3

SERVICE AND MAINTENANCE

DH-3.1 INTRODUCTION.

If the system fault-localization procedure of Section 5 of the front portion of the manual indicates possible malfunction of the RDI-3 unit, the most positive verification of this suspicion is the substitution of another RDI-3 unit.

NOTE

Temporary substitution of a DI-3 unit would also be helpful if the failure was not related strictly to the remote frequency-selection circuits.

If this step restores the instrument to normal operation, the defective unit should, if possible, be returned to the General Radio Company for service and repair, especially if it is within the two-year warranty.

Since there is but one such unit per synthesizer, and since service spares may not be available, it will not always be possible to make the substitution as outlined above. Where this is not possible, selected tests and a few alignment steps may be made in the field. The synthesizer cannot operate without a properly functioning DI-3 or RDI-3 module.

CAUTION

Many alignment procedures require the use of special test fixtures and cannot be accomplished in the field.

A thorough knowledge of the principles of operation, and all of the circuit arrangements by which the desired operation is achieved, is essential before RDI-3 module service is attempted.

DH-3.2 TEST EQUIPMENT.

Recommended test equipment is listed and described in Table DH-2; equivalent equipment may be substituted.

TABLE DH-2
TEST EQUIPMENT

Function	*Type Recommended*	*Minimal Characteristics*
Electronic Voltmeter (VTVM)	GR 1806 (with 1806-P1 Probe)	2% accuracy; ac and dc capabilities
Dual-Trace Sampling Oscilloscope	Tektronix 661 with 4S1 and 5T1A plug-ins and P6032 CF Probe	1000 MHz; high-impedance probe
Digital Counter	GR 1191 (with 1157 Scaler)	Up to 150 MHz with 5-place readout
Standard Sweep Frequency Generator	GR 1025	Calibration accuracy – 0.5%

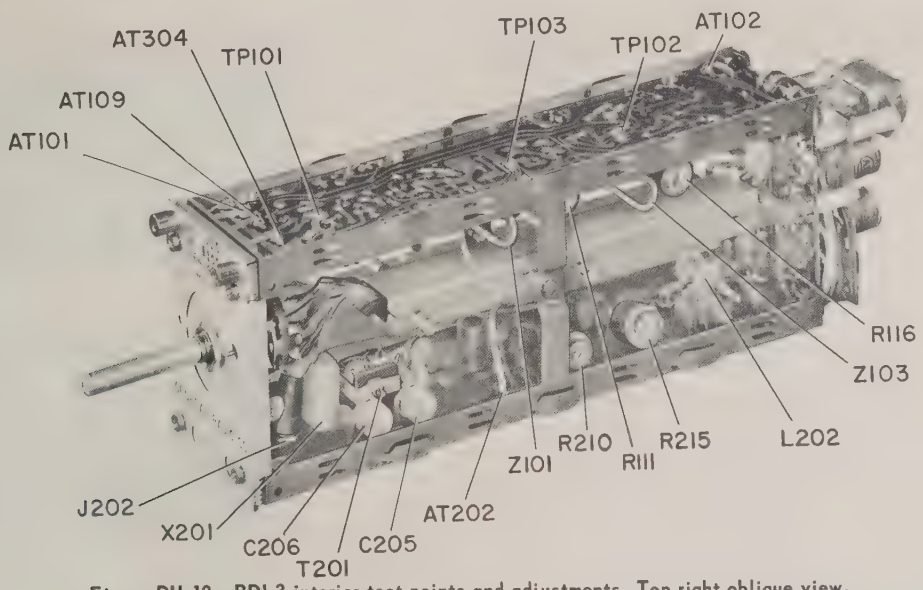


Figure DH-10. RDI-3 interior test points and adjustments. Top right oblique view.

DH-3.3 TROUBLE ANALYSIS.

CAUTION

Turn synthesizer power off during set-up changes to avoid accidental short circuits.

DH-3.3.1 GENERAL.

Remove the Type 1164 from its cabinet. Remove the DI-2 module from Station II, and remove the RDI-3, after disconnecting the short coaxial cable at the bottom of the synthesizer. Disconnect the cable from J101 on the OMM-3 module (Figure DH-16), lift it out with the module. For other procedural details refer to paragraph 5.4.2 in the front portion of this manual.

Remove the 6 side screws and two bottom screws from the RDI-3 module and slide the cover off. Reinstall the module (less cover) on the chassis. The DI-2 should not be reinstalled at this time.

Refer to Figures DH-10 and DH-11 for the locations of test points and secondary adjustments referred to in procedures that follow. See also Figure DH-22, the over-all schematic diagram.

The most common symptoms of failure within the RDI-3 will be the generation of improper frequencies or the failure to give any output whatever. Procedures that follow will give assurance that the difficulty is in the RDI-3 module and not in some other unit and will facilitate fault isolation to the detail-part level.

DH-3.3.2 POWER INPUT.

With the VTVM, look for +18 ±0.2 Vdc at AT101 on the top circuit board. If the indication is abnormal,

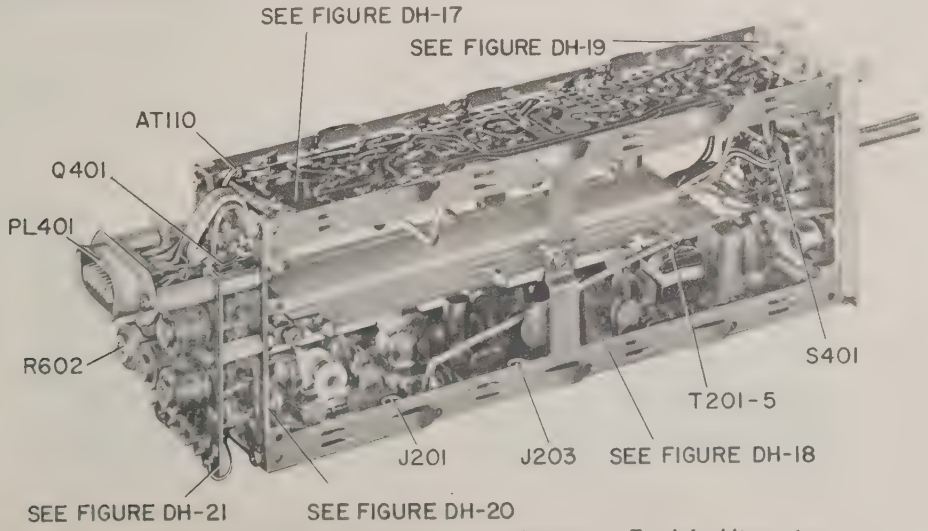


Figure DH-11. RDI-3 interior test points and adjustments. Top left oblique view.

look at J201 at the bottom circuit board. If the voltage is correct at J201, but is incorrect elsewhere, the malfunction is in the RDI-3. If J201 indicates an incorrect voltage, check the power supply and chassis-power distribution in the sandwich deck (refer to Sections BC and GB).

DH-3.3.3 5-MHz CIRCUITS.

With the oscilloscope, look for the 5-MHz input from the AFS module at J203. If the input signal is missing, distorted, or less than 0.25 V, rms, check the Main Frame (Section BC) and the AFS (Section CA). This test is independent of the setting of the synthesizer front-panel controls.

If the 5-MHz input is normal, observe the 5 MHz at pin 5 of T201. If no 5-MHz signal is present, the 5-MHz buffer stage, Q201, is inoperative. Next, observe the waveform at TP101 (top board, foil side). It should appear as in Figure DH-12. T201 can be adjusted to maximize this signal.

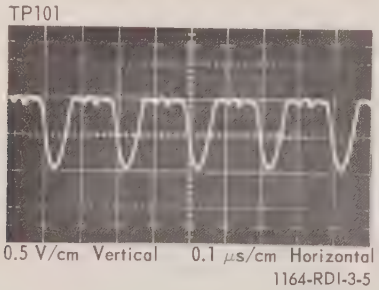


Figure DH-12. Waveform at TP101 (see Figure DH-10).

If no signal is present, check the pulse-clipper stages, Q101 and Q102, the drive signal to Q101 (at AT104), and the crystal filter. Input to the crystal filter can be observed at T201-1 and output at AT304 (front board).

A sweeping frequency source of narrow range, such as a Type 1163-A7C synthesizer equipped with Type 1160-P2 Sweeper accessory, is required to check the characteristic of the crystal filter, along with a means of connecting it into the instrument. This is not normally a field adjustment.

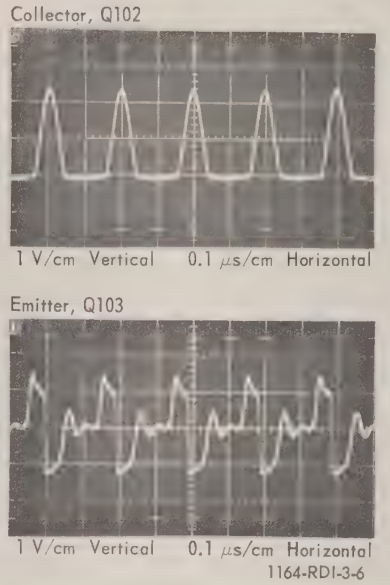


Figure DH-13. Typical input and output waveforms for the servo-circuit pulse amplifier (see Figure DH-17).

DH-3.3.4 PULSE CIRCUITS.

The simplest approach to isolate trouble in stages Q101-Q104 is to signal-trace the various waveforms until a defective circuit is located. Figure DH-13 (A) shows the waveform at the collector of Q102, the input of the pulse amplifier; the output at the emitter of Q103 is shown at Figure DH-13 (B).

R109 controls the amplitude of the blocking-oscillator pulse, the waveform of which can be observed at the collector of Q104 (case).

CAUTION

Do not change the setting of R109 unless there is a strong reason to do so, since a change in pulse amplitude can upset the sampler balance.

The sampling oscilloscope is needed for the remainder of the pulse circuits. Figure DH-14 (A) shows the output of the blocking oscillator at pin 1, T101, (use Figure DH-17 to find the test point). The waveform of the final pulse is seen at TP103, Figure DH-14 (B).

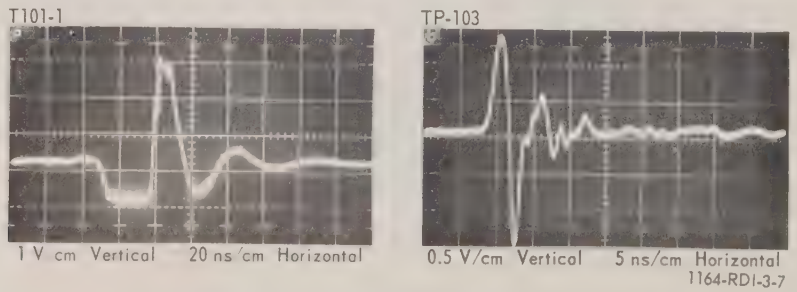


Figure DH-14. Sampling oscilloscope waveforms typical of servo-circuit blocking-oscillator performance.

DH-3.3.5 RF CIRCUITS.

A rough estimate of the performance of the 120 to 150 MHz sections of the module can be made by signal tracing with the oscilloscope and VTVM (see Figure DH-10).

A frequency equal to the digit-output frequency should be found progressively at the following points: pin 4, L202, at approximately 0.5 V, rms; J202 (rf output) 0.3 V, rms, (adjustable by R215); and AT202 and AT102 at about 50 - 100 mV, rms, depending on the factory setting of servo control loop-gain (see Figure DH-18 for test points).

If gain control R210 or other elements in the servo loop become faulty, or misadjusted, the servo-control circuit may oscillate and inhibit normal phase-lock operation. Figure DH-15 is indicative of this symptom, as seen at AT109. CCW adjustment of R210 should stop this condition, but usually insufficient capture range results. If this adjustment is ineffective the unit should be returned to General Radio Company for repair.

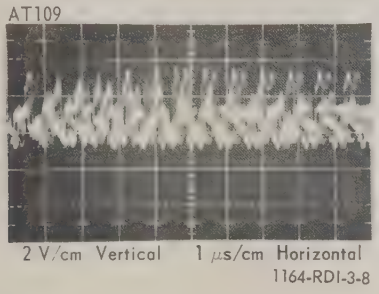


Figure DH-15. Typical waveform at AT109, indicating self-oscillation resulting from an incorrect setting of R210, the digit oscillator control-loop gain control.

DH-3.3.6 DC AMPLIFIER.

Table DH-3 includes the voltages that should be obtained in the dc amplifier circuits.

DH-3.3.7 NOTCH FILTER.

Remove Q104 to stop the pulse generator. Set the digit dial to "R." Connect the VTVM (dc mode) to AT110 and adjust R116 to a 12.0 Vdc indication.

Connect the signal generator to the base of Q105, through a 0.01-μF coupling capacitor. Sweep through 5 MHz at 0.1 V, rms, and with the VTVM (ac mode), observe the voltage at AT110. The ac voltage output of the amplifier should go through a minimum at 5 MHz. If the notch can't be found, the unit must be returned to General Radio for repair.

DH-3.3.8 FREQUENCY SELECTOR CIRCUITS.

If one or a few digits fail to program properly but the unit functions normally otherwise, the trouble may be in the selector circuits. If any digit gives "0" instead of the correct value, trace through the wiring for opens between PL401, S401, and the appropriate switching transistor pair Q401-Q412. If one digit, other than 0, gives the same value in 0 and its own place but the other frequencies are wrong, check for shorts in the circuits associated with the digit in question.

Note that digit "0" is set with L202 while all remaining digits are set with one of the potentiometer controls, R601-R606.

CAUTION

These controls should not be moved – their proper alignment requires a special test cover.

Access to the two rear boards for component replacement is facilitated by loosening the rear board and PL401 and swinging them out of the way.

DH-3.4 DC VOLTAGE CHECKS.

The procedures in paragraph DH-3.3 should narrow the search for circuit defects to a circuit function consisting of one or, at the most, a few stages. As a further aid to pinpointing the defective part, the information on dc voltage readings is presented in Table DH-3.

DH-3.5 REPAIRS AND REPLACEMENT.

Replace defective detail parts (with frequency-insensitive functions) to correct deficiencies indicated by the trouble-analysis procedures.

TABLE DH-3
DC VOLTAGE INDICATIONS

Transistor	*Emitter*	*Base*	*Collector*
Q101	9.5	9.0	0
Q102	9.5	9.0	0
Q103	0	0	15.3
Q104	.32	0	3.9
Q105	11.5	12	16.5
Q106	11.5	12	18
Q107	17.4	16.5	11.7
Q201	9.7	9.1	0
Q202	9.9	9.2	0.67
Q203	7.0	7.7	16.5
Q204	7.0	7.7	16.5
Q301	13	12.5	9.6
Q302	2.32	2.1	2.3
Q401* ON	18	17.4	18
Q402* ON	0	0.75	0.15
Q403,5,7, etc* OFF	18	18	0
Q404,6,8, etc* OFF	0	0	**

NOTE:
*Q400 Series transistors are switches whose bias voltages are determined by their state, "on" or "off." They operate in pairs, one pair being on at a time, or all off if digit "0" is selected. If digit "1" is selected, pair Q401/Q402 is on, as shown in the table above. If digit "2" is selected, pair Q403/Q404 is on, etc.
**The "off" collector voltages are the same, and range from 1.5 to 12 V, depending on the digit selected.

Figure DH-16. Rf output connector on RDI-3 module, shown looking from underside of synthesizer.

CAUTION

Replacement of frequency-determining parts will require realignment that cannot be accomplished without special test fixtures.

Figures DH-17 through DH-21 show the physical layout of the parts on the various etched-circuit boards, to speed positive identification. The reference designators for the parts shown on the boards are the same as those used in the overall schematic diagram, Figure DH-22, and in the parts list at the end of this section. Circuit details for the FP-2 Filter Plug are shown in Figures DH-23 and DH-24.

Figure DH-17. Etched-circuit board assembly (top) for RDI-3 (P/N 1164-2766).

Figure DH-18. Etched-circuit board assembly (bottom) for RDI-3 (P/N 1164-2725).

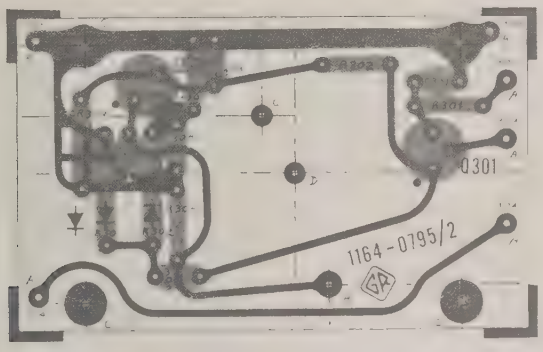


Figure DH-19. Etched-circuit board assembly (front) for RDI-3 (P/N 1164-2795).

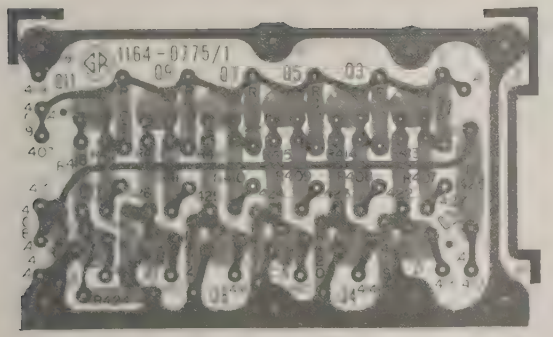


Figure DH-20. Etched-circuit board assembly (rear 1) for RDI-3.

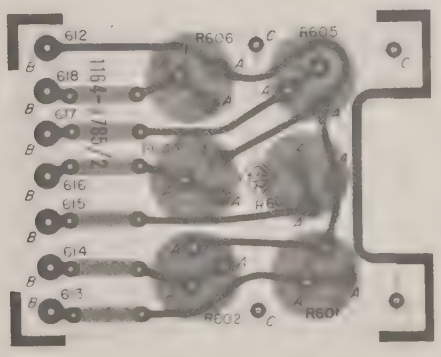


Figure DH-21. Etched-circuit board assembly (rear 2) for RDI-3 (P/N 1164-2785).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

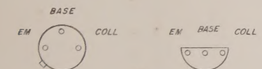
PARTS LIST

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C102	Electrolytic, 1.0 µF ±10% 35 V	4450-4301
C103	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C104	Ceramic, 470 µF ±10% 500 V	4405-1478
C105	Electrolytic, 1.0 µF ±10% 35 V	4450-4301
C106	Ceramic, 0.02 µF +80-20% 50 V	4402-3200
C107	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C108	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C109	Ceramic, 12 pF ±5% 500 V	4411-0125
C110	Electrolytic, 1.0 µF ±10% 35 V	4450-4301
C111	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C112	Electrolytic, 2.2 µF ±20% 20 V	4450-4500
C113	Ceramic, 56 pF ±5% 500 V (N750)	4417-0565
C114	Trimmer, 5.5 - 18 pF 350 V (NPO)	4910-2031
C115	Ceramic, 62 pF ±5% 500 V	4410-9625
C116	Ceramic, 43 pF ±5% 500 V (N470)	4416-0435
C201	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C202	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C203	Mica, 100 pF ±1% 500 V	4710-0010
C204	Ceramic, 20 pF ±5% 500 V (N750)	4417-0205
C205	Ceramic, 2 - 8 pF 350 V (NPO)	4910-2033
C206	Trimmer, 7 - 25 pF 350 V (N300)	4910-2032
C207	Ceramic, 22 pF ±5% 500 V (NPO)	4410-0225
C208	Ceramic, 0.001 µF ±5% 500 V	4405-2105
C209	Ceramic, 43 pF ±5% 500 V (N470)	4416-0435
C210	Ceramic, 5.1 pF ±5% 500 V (N750)	4417-9515
C211 thru C219	Ceramic, 0.001 µF ±5% 500 V	4405-2105
C220	Ceramic, 0.1 pF +80-20% 50 V	4403-4100
C301 thru C305	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
	DIODES	
CR101 thru CR103	Type 1N3604	6082-1001
CR104A, CR104B, CR104C, CR104D	Type MSQ 100520	6082-1023
CR105	Type TI56	6082-1016
CR201	Type 1N5144	6084-1022
CR202	Type 1N5144	6084-1022
CR203	Type 1N3604	6082-1001
CR301	Type 1N191	6082-1008
CR302	Type 1N191	6082-1008
CR303	Type TI56	6082-1016
	RESISTORS	
R101	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335
R102	Composition, 680 Ω ±5% 1/4 W	6099-1685
R103	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R104	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R105	Composition, 100 Ω ±5% 1/4 W	6099-1105
R106	Composition, 330 Ω ±5% 1/4 W	6099-1335
R107	Composition, 390 Ω ±5% 1/4 W	6099-1395
R108	Composition, 680 Ω ±5% 1/4 W	6099-1685
R109	Potentiometer, wire wound 2 kΩ ±5% 1/4 W	6053-1105
R110	Composition, 220 Ω ±5% 1/4 W	6099-1225
R111	Composition, 100 Ω ±20%	6049-0740
R112	Composition, 51 Ω ±5% 1/4 W	6099-0515
R113	Film, 5.76 kΩ ±1% 1/8 W	6250-1576
R114	Film, 11.8 kΩ ±1% 1/8 W	6250-2118
R115	Composition, 820 kΩ ±5% 1/4 W	6099-4825
R116	Potentiometer, wire wound 10 kΩ ±5%	6053-3105
R117	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R118	Film, 1.0 kΩ ±1% 1/8 W	6250-1100
R119	Film, 2.0 kΩ ±1% 1/8 W	6250-1200
R120	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225
R121	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395
R122	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335
R123	Composition, 18 kΩ ±5% 1/4 W	6099-3185
R201	Composition, 470 Ω ±5% 1/4 W	6099-1475
R202	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R203	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R204	Composition, 22 Ω ±5% 1/4 W	6099-0225
R205	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335
R206	Composition, 120 Ω ±5% 1/4 W	6099-1125
R207	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R208	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395
R209	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R210	Potentiometer, composition 250 Ω ±20%	6040-0200
R211	Composition, 680 Ω ±5% 1/4 W	6099-1685
R212	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R213	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R214	Composition, 150 Ω ±5% 1/4 W	6099-1155
R215	Potentiometer, composition 100 Ω ±20%	6040-0100
R216	Composition, 680 Ω ±5% 1/4 W	6099-1685
R217	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R218	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R219	Composition, 150 Ω ±5% 1/4 W	6099-1155
R301	Composition, 680 Ω ±5% 1/4 W	6099-1685
R302	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R303	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R304	Composition, 330 Ω ±5% 1/4 W	6099-1335
R401 thru R412	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R413 thru R418	Composition, 18 kΩ ±5% 1/4 W	6099-3185
R419 thru R424	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R425	Film, 1.5 kΩ ±1% 1/8 W	6250-1150
R426	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R601	Potentiometer, composition 2.5 kΩ ±20%	6040-0500
R602	Potentiometer, composition 1 kΩ ±20%	6040-0400
R603	Potentiometer, composition 500 Ω ±20%	6040-0300
R604	Potentiometer, composition 500 Ω ±20%	6040-0300
R605	Potentiometer, composition 250 Ω ±20%	6040-0200
R606	Potentiometer, composition 250 Ω ±20%	6040-0200
R607	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185
R608	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R609	Composition, 680 Ω ±5% 1/4 W	6099-1685
R610	Composition, 330 Ω ±5% 1/4 W	6099-1335
R611	Composition, 300 Ω ±5% 1/4 W	6099-1305
R612	Composition, 180 Ω ±5% 1/4 W	6099-1185
	TRANSISTORS	
Q101	Type 2N3638	8210-1096
Q102	Type 2N3638	8210-1096
Q103	Type 2N708	8210-3089
Q104	Type 2N3866	8210-1120
Q105	Type 2N3390	8210-1077
Q106	Type 2N3390	8210-1077
Q107	Type 2N3906	8210-1112

PARTS LIST (Cont)

REF NO	DESCRIPTION	PART NO
	TRANSISTOR (cont)	
Q201	Type 2N3905	8210-1114
Q202	Type 2N3546	8210-1140
Q203	Type 2N2369	8210-1052
Q204	Type 2N2218	8210-1028
Q301	Type 2N3906	8210-1112
Q302	Type 2N1305	8210-1125
Q401	Type 2N4125	8210-1125
Q402	Type 2N4123	8210-1123
Q403	Type 2N4125	8210-1125
Q404	Type 2N4123	8210-1123
Q405	Type 2N4125	8210-1125
Q406	Type 2N4123	8210-1123
Q407	Type 2N4125	8210-1125
Q408	Type 2N4123	8210-1123
Q409	Type 2N4125	8210-1125
Q410	Type 2N4123	8210-1123
Q411	Type 2N4125	8210-1125
Q412	Type 2N4123	8210-1123
	MISCELLANEOUS	
X201	CRYSTAL, 5 MHz	1213-0440
Z101	CABLE, Delay line, rigid-wall coaxial, miniature	1163-0201
Z102	CABLE, Delay line, rigid-wall coaxial, miniature	1163-0202
Z103	CABLE, Delay line, rigid-wall coaxial, miniature	1163-0203
Z104	CABLE, Delay line, rigid-wall coaxial, miniature	1163-0204
Z201	CABLE, Delay line, rigid-wall coaxial, miniature	1164-2415

REF NO	DESCRIPTION	PART NO
	MISCELLANEOUS (Cont)	
L101	INDUCTOR, choke molded, 22 µH ±10%	4300-2600
L102 thru L104	INDUCTOR, choke molded, 1.5 µH ±10%	4300-1000
L105	INDUCTOR, choke molded, 22 µH ±10%	4300-2600
L106	INDUCTOR, choke molded, 22 µH ±10%	4300-2600
L107	INDUCTOR, choke molded, 15 µH ±10%	4300-2400
L201	INDUCTOR, choke molded, 3.3 µH ±10%	4300-1401
L202	INDUCTOR, choke molded	1164-2380
J201	JACK, etched-circuit eyelet-type	1160-6110
J202	JACK, etched-circuit eyelet-type Part of Z201	4260-1310
J203	JACK, etched-circuit eyelet-type	1160-6110
PL401	PLUG, Connector, multiple	4220-5307
S401	SWITCH, Rotary wafer	7890-5150
T101	TRANSFORMER, video, interstage	5000-2601
T102	TRANSFORMER, video, interstage	5000-2403
T201	TRANSFORMER, video, interstage	5000-2837
T202	TRANSFORMER, video, interstage	5000-2408
T203	TRANSFORMER, video, interstage	5000-2408
—	Knob, dial assembly	1164-1850
—	Lamp assembly	1160-2080
	ETCHED-CIRCUIT BOARD	
	Top etched-circuit board	1164-2766
	Bottom etched-circuit board	1164-2725
	Front etched-circuit board	1164-2795
	Rear etched-circuit board (inside)	1164-2779
	Rear etched-circuit board (outside)	



TRANSISTOR BASE DIAGRAMS (BOTTOM VIEW)

S401 SHOWN IN DIAL POSITION "R"

DIAL

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

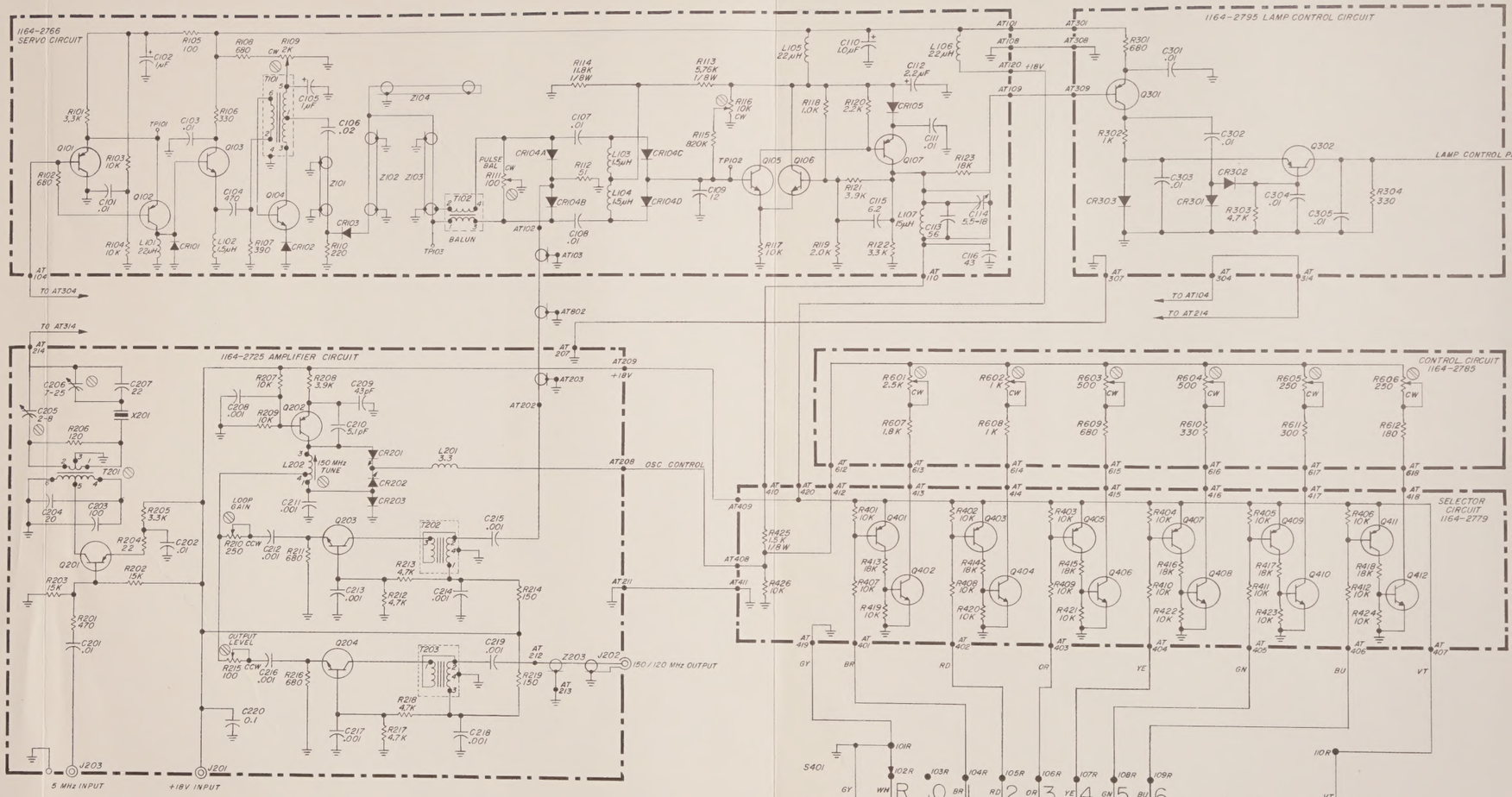


Figure DH-22. Overall schematic diagram for Remotely Programmable Digit Insertion Unit RDI-3 (P/N 1164-4015).

PARTS LIST

(Used only with schematic diagram, Figure DH-24)

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101 thru C111	Ceramic, 0.001 µF ±10% 500 V	4405-2108
C112	Ceramic, 1 µF ±20% 25 V	4400-2070
	RESISTORS	
R101 thru R111	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R112 thru R122	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335
R123	Composition, 47 Ω ±5% 1/4 W	6099-0475
R124	Composition, 47 Ω ±5% 1/4 W	6099-0475
R125	Composition, 100 Ω ±5% 1/4 W	6099-1105
	SOCKET	
SO101	Socket, multipin, Amphenol 57-20140	4230-5004

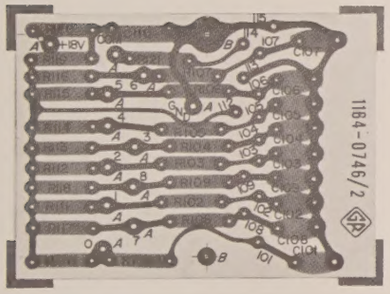


Figure DH-23. Etched-circuit board assembly for RDI-3 Filter Plug (P/N 1164-2746).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED

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2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

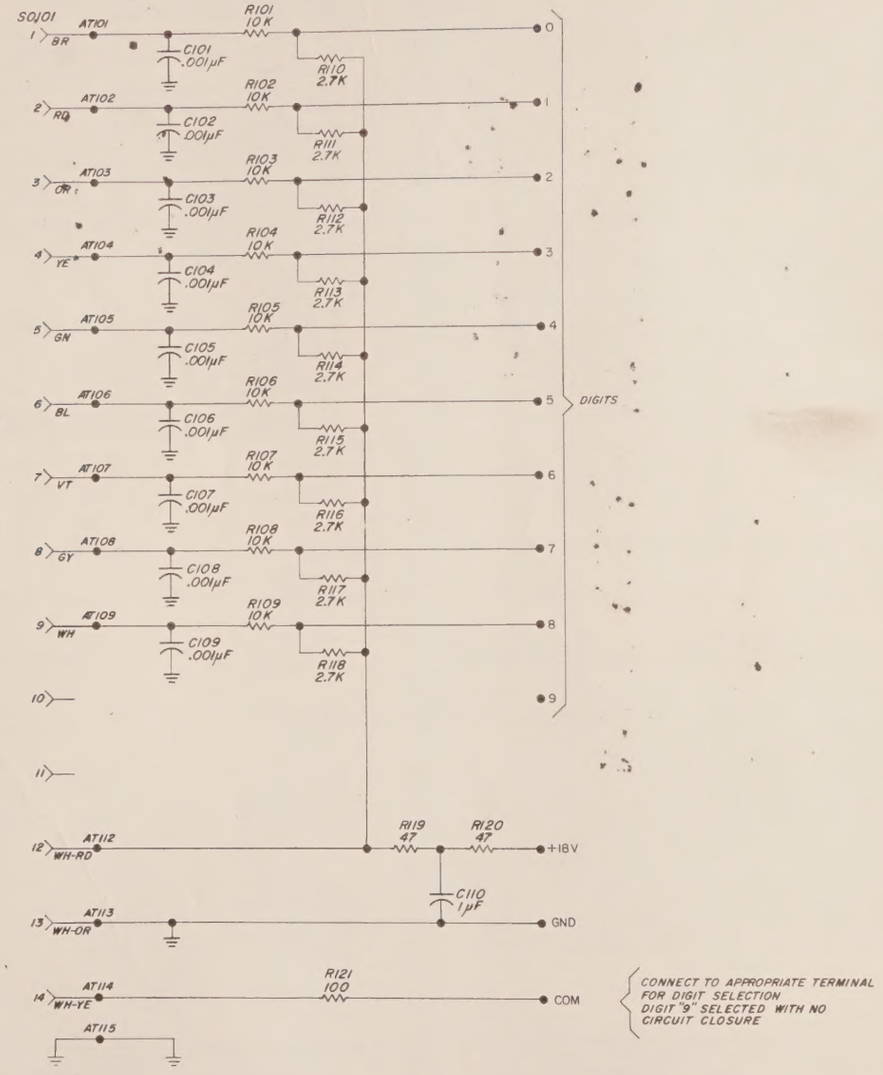
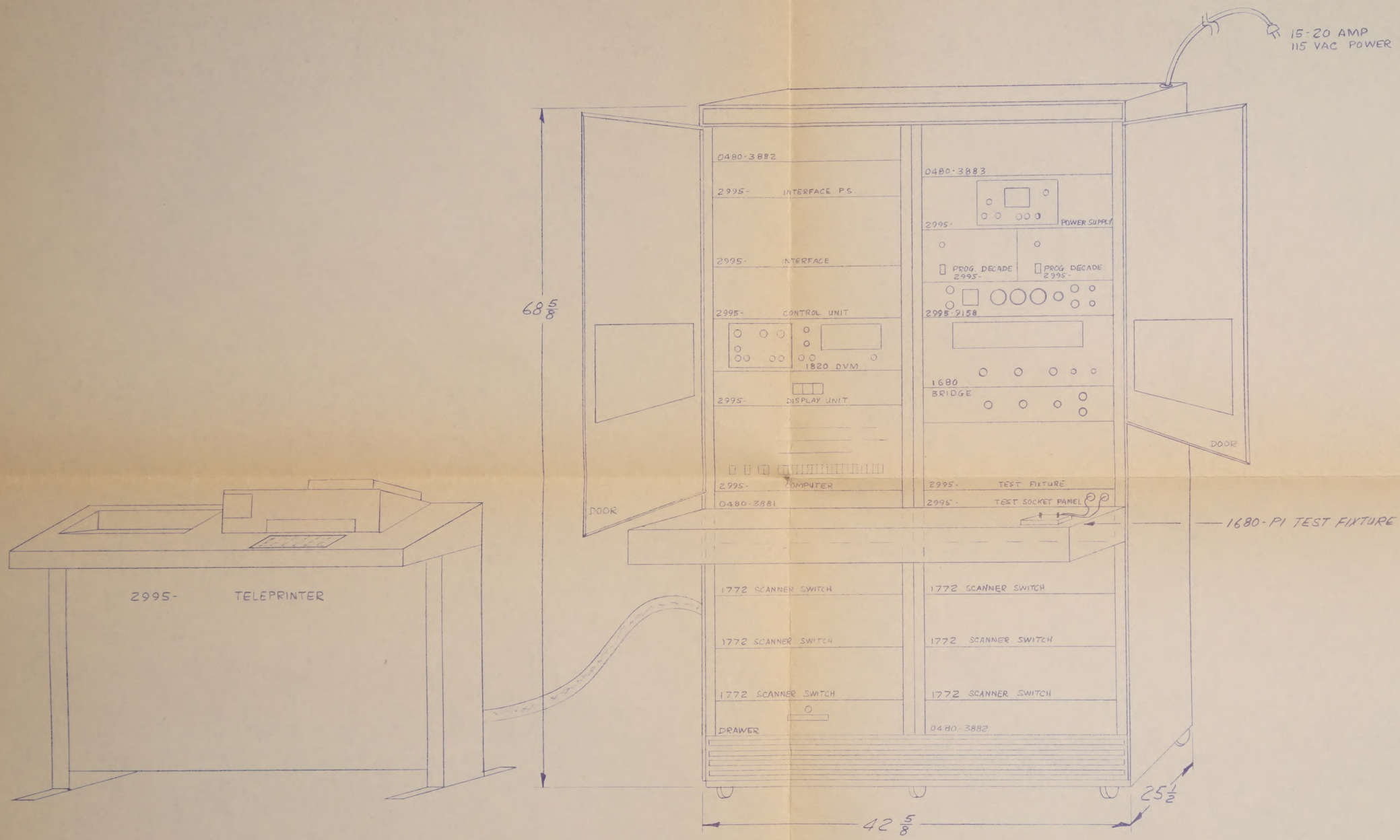


Figure DH-24. Overall schematic diagram for Filter Plug FP-2 (P/N 1164-4090).



AUTOMATIC CAPACITOR - TESTING SYSTEM Q540A

NOTE:
1. APPROX WEIGHT 1400 LBS INCLUDING TELEPRINTER.

NUMBER	ISSUE
Q540A-ID	1
DATE: 8-23-68	ISSUE 1

REVISIONS

SCALE 1/8	FIRST USED ON	
DR. ARG	CH.	APP.

GENERAL RADIO COMPANY
W. CONCORD, MASS. U.S.A.

NUMBER	ISSUE
Q540A-ID	1

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. KNOB CONTROL
8. SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

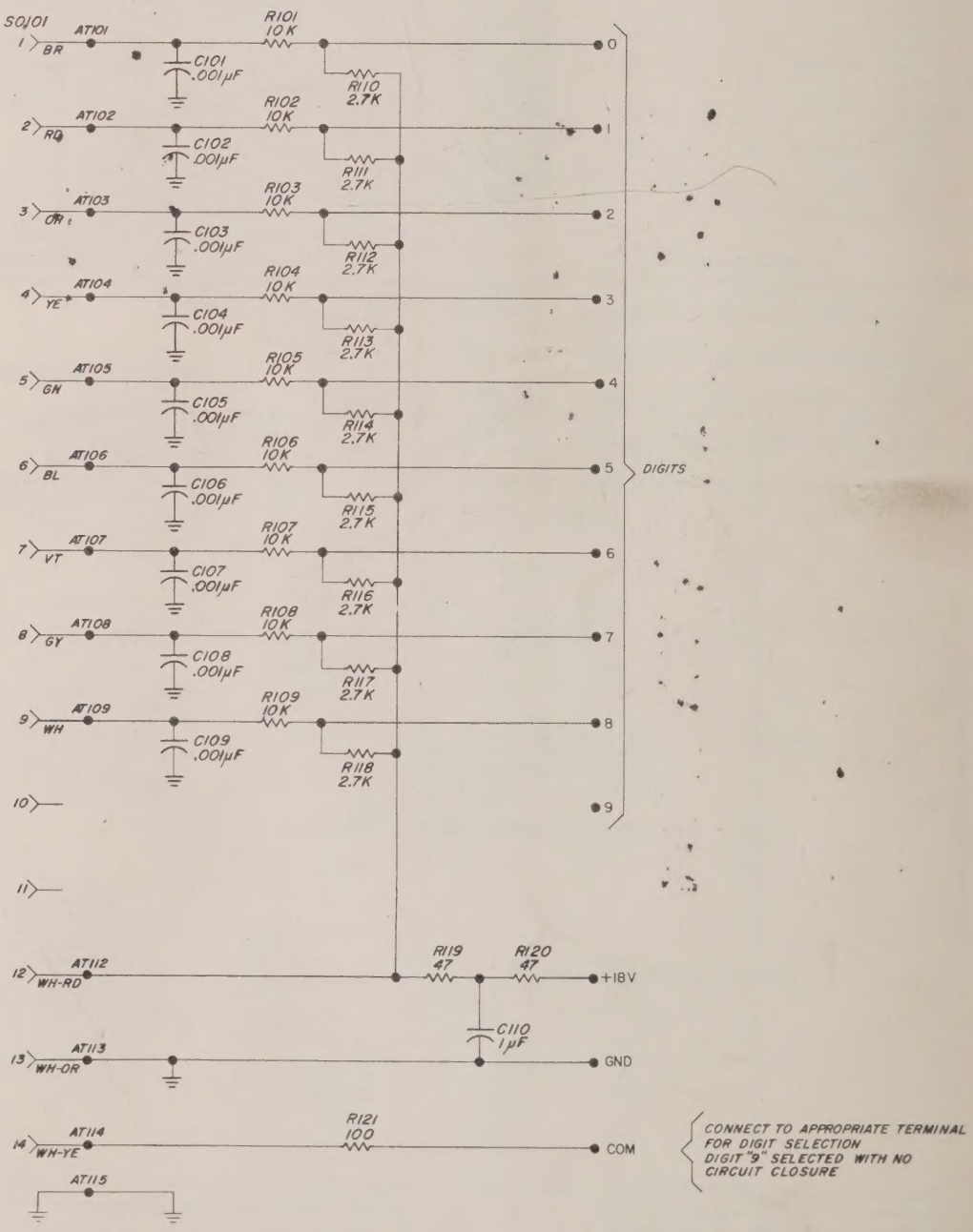


Figure DH-24. Overall schematic diagram for Filter Plug FP-2 (P/N 1164-4090).